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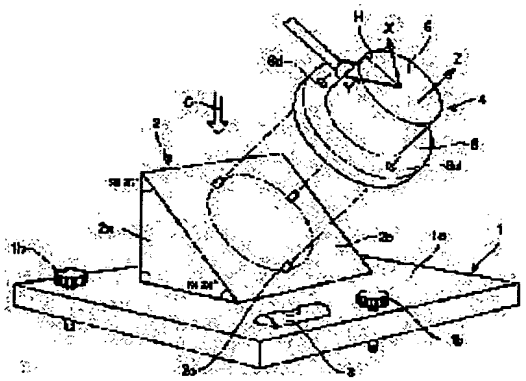
(54) 3-AXIS ACCELEROMETER CALIBRATION JIG

(57)Abstract:
PROBLEM TO BE SOLVED: To rapidly perform calibration work by providing an accelerometer attaching surface which forms a specified angle for the flat plane orthogonal to the gravitational acceleration direction to allow easier attaching work of an accelerometer to a calibration jig.
SOLUTION: An attaching surface 2b, forming an angle tan-1 (21/2) (about 54.74°) against a flat plane 1a orthogonal to the gravitational acceleration direction, is provided to a block 2. On the attaching surface 2b, a three axis accelerometer 4 is so attached that gravitrational acceleration equal to X-direction sensitive axis and Y-direction sensitive axis of the accelerometer 4 acts. Then, on each X, Y and Z axis acceleration sensor, the identical acceleration component (about 57.4% of gravitational acceleration G) due to the gravitational acceleration G acts. Thus, by adjusting a gain of an amplifier, a display, etc., with a calibration device so that the output voltage of each axis acceleration sensor displays the identical value, sensitivity calibration can be performed by attaching a calibration jig to the accelerometer 4 only once.



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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] the clamp face where an include angle becomes tan-1 (21/2) to the flat surface which is said fixture for proofreading which fixes an accelerometer three shaft when performing the sensitivity calibration of an accelerometer three shaft using gravitational acceleration, and intersects perpendicularly with the gravitational-acceleration direction -- having -- this clamp face -- said three shaft characterized by said thing [attaching an accelerometer three shaft] so that gravitational acceleration equal to the direction sensitive axis of X and the direction sensitive axis of Y of an accelerometer may act three shaft -- an accelerometer -- the fixture for proofreading.
[Claim 2] the clamp face where an include angle becomes tan-1 (21/2) to the flat surface which is said fixture for proofreading which fixes an accelerometer three shaft when performing the sensitivity calibration of an accelerometer three shaft using excitation equipment, and intersects perpendicularly with the acceleration direction -- having -- this clamp face -- said three shaft characterized by said thing [attaching an accelerometer three shaft] so that acceleration equal to the direction sensitive axis of X and the direction sensitive axis of Y of an accelerometer may act three shaft -- an accelerometer -- the fixture for proofreading.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] three shaft which has the sensitive axis with which this invention intersects perpendicularly mutually and which is used on the occasion of the sensitivity calibration of an accelerometer three shaft -- an accelerometer -- it is related with the fixture for proofreading.
[0002]
[Description of the Prior Art] three conventional shaft -- an accelerometer -- as the fixture for proofreading -- the accelerometer of rectangular cross 3 shaft (X, Y, Z), for example, a servo, -- when performing the sensitivity calibration of an accelerometer using gravitational acceleration, in order to make the direction of a sensitive axis in agreement in the gravitational acceleration direction, the fixture for proofreading which refixes an accelerometer for every sensitive axis is known. moreover, a piezo-electric form -- also when performing the sensitivity calibration of an accelerometer using excitation equipment, in order to make the direction of a sensitive axis in agreement in the acceleration direction, the fixture for proofreading which refixes an accelerometer for every sensitive axis is known.
[0003] Namely, make the fixture for proofreading fix an accelerometer, and although the sensitivity calibration of three shafts is performed, sensitivity settling is performed so that it may become predetermined sensibility, so that the acceleration direction may be in agreement with the sensitive axis of a Z-axis acceleration sensor first. Subsequently, make an accelerometer fix to the fixture for proofreading, and sensitivity settling is performed so that it may become predetermined sensibility, so that the acceleration direction may be in agreement with the sensitive axis of an X-axis acceleration sensor. Furthermore, an accelerometer is made to fix to the fixture for proofreading, and sensitivity settling is performed so that it may become predetermined sensibility, so that the acceleration direction may be in agreement with the sensitive axis of a Z-axis acceleration sensor.
[0004]
[Problem(s) to be Solved by the Invention] three conventional shaft -- an accelerometer -- in the fixture for proofreading, whenever it performed sensitivity settling of each shaft, the accelerometer had to be refixed, attachment of the acceleration to the fixture for proofreading was complicated, and it was difficult to perform a sensitivity calibration quickly.
[0005] three shaft with which the place which this invention is made in view of such a trouble that a Prior art has, and is made into the purpose can perform the sensitivity calibration of an accelerometer three shaft by the attachment to 1 time of the fixture for proofreading -- an accelerometer -- it is going to offer the fixture for proofreading.
[0006]
[Means for Solving the Problem] the clamp face where an include angle becomes tan-1 (21/2) to the flat surface which is said fixture for proofreading which fixes an accelerometer three shaft when invention of claim 1 performs the sensitivity calibration of an accelerometer three shaft using gravitational acceleration, and intersects perpendicularly with the gravitational-acceleration direction that the above-mentioned technical problem should be solved -- having -- this clamp

face -- said -- as gravitational acceleration equal to the direction sensitive axis of X and the direction sensitive axis of Y of an accelerometer acts three shaft, it is said thing which attaches an accelerometer three shaft.
[0007] the clamp face where an include angle becomes tan-1 (21/2) to the flat surface which is said fixture for proofreading which fixes an accelerometer three shaft when invention of claim 2 performs the sensitivity calibration of an accelerometer three shaft using excitation equipment, and intersects perpendicularly with the acceleration direction -- having -- this clamp face -- said -- as acceleration equal to the direction sensitive axis of X and the direction sensitive axis of Y of an accelerometer acts three shaft, it is said thing which attaches an accelerometer three shaft.
[0008]
[Embodiment of the Invention] The gestalt of operation of this invention is explained based on an accompanying drawing below. three shaft which drawing 1 requires for invention of claim 1 here -- an accelerometer -- three shaft for which the perspective view of the fixture for proofreading and drawing 2 spend for the configuration explanatory view of an accelerometer, and drawing 3 spends three shaft to invention of claim 1 -- an accelerometer -- three shaft for which the operation explanatory view of the fixture for proofreading and drawing 4 spend for the outline block diagram of the calibrating apparatus of an accelerometer, and drawing 5 spends three shaft to invention of claim 2 -- an accelerometer -- three shaft which the perspective view of the fixture for proofreading and drawing 6 require for invention of claim 2 -- an accelerometer -- it is the operation explanatory view of the fixture for proofreading.
[0009] three shaft concerning invention of claim 1 -- an accelerometer -- the fixture for proofreading consists of block 2 laid in top-face 1a of the metal pedestal 1 and a pedestal 1 as shown in drawing 1 , and adjusting-screw 1b for making the horizontal plane which intersects perpendicularly with the gravitational acceleration direction at top-face 1a form is prepared in the pedestal 1. In addition, 3 is level which checks that top-face 1a of a pedestal 1 becomes a horizontal plane.
[0010] Block 2 is formed in the right-angle triangle pole with a metallic material (for example, aluminum), and the include angle of each vertical angle of the right triangle which are top-face 2a of the right-angle triangle pole and a base becomes about 35.26 degrees by 90 degrees and tan-1 (2-1/2), and has become about 54.74 degrees by tan-1 (21/2), respectively. In addition, about the reason for having set up the include angle of each vertical angle as mentioned above, it mentions later.
[0011] And top-face 1a of a pedestal 1 is touched in the side face of the right-angle triangle pole in which a 35.26-degree vertical angle counters, and the block 2 is laid in top-face 1a of a pedestal 1. Moreover, three pin 2c which carries out positioning immobilization of the accelerometer 4 three shafts protrudes on clamp-face 2b which is the side face of the right-angle triangle pole in which a 90-degree vertical angle counters perpendicularly. Therefore, clamp-face 2b will form about 54.74-degree flat surface to about 35.26 degrees and top-face 1a of a pedestal 1 to the gravitational acceleration direction.
[0012] the servo which an accelerometer 4 makes a sensitive axis intersect perpendicularly mutually, arranges the X-axis acceleration sensor 5, the Y-axis acceleration sensor 6, and the Z-axis acceleration sensor 7 in top-face 8a of the disc-like base 8 as shown in drawing 2 , and it puts the cylinder-like case 9 on top-face 8a of the base 8, is constituted three shaft, and has sensibility also in gravitational acceleration (DC field) -- it is an accelerometer. in addition, for example, the strain gage type which has the sensibility of DC field as an accelerometer 4 three shafts -- an accelerometer may be used.
[0013] The X-axis acceleration sensor 5 and the Y-axis acceleration sensor 6 are arranged in parallel [those sensitive axes] with top-face 8a of the base 8, and the Z-axis acceleration sensor 7 is arranged at right angles [the sensitive axis] to top-face 8a of the base 8. Moreover, 8d of mounting holes which fit in pin 2c, are made to stick base 8c of the base 8 to clamp-face 2b of block 2, and are fixed to block 2 is formed in flange 8b of the base 8.
[0014] If an accelerometer 4 is fixed to clamp-face 2b of block 2 three shaft, in the X-axis acceleration sensor 5 and the Y-axis acceleration sensor 6, those sensitive axes will become

parallel to clamp-face 2b, and, as for the Z-axis acceleration sensor 7, the sensitive axis will become perpendicular to clamp-face 2b.
[0015] three shaft concerning invention of claim 1 constituted as mentioned above -- an accelerometer -- an operation of the fixture for proofreading is explained. As shown in drawing 1 R> 1, pin 2c is fitted into 8d of mounting holes, and an accelerometer 4 is fixed to block 2 three shaft. At this time, as shown in drawing 3 (a), gravitational acceleration G, clamp-face 2b of block 2, and the include angle to make are set to theta. Then, a component parallel to clamp-face 2b of the block 2 of gravitational acceleration G is set to G-costheta, and a perpendicular component is set to G-sintheta.
[0016] And as shown in drawing 3 (b), an accelerometer 4 is fixed to clamp-face 2b of block 2 three shafts so that it may be in agreement with the shaft H with which the direction of G-costheta which is the component of gravitational acceleration G divides into two equally the angle (90 degrees) which direction sensitive-axis of X 5a of an accelerometer 4 and direction sensitive-axis of Y 6a make three shafts.
[0017] Therefore, G-sintheta which is a component perpendicular to clamp-face 2b acts on Z direction sensitive-axis 7a, and 45 degree of G-cos theta-cos act on direction sensitive-axis of X 5a, and direction sensitive-axis of Y 6a. Here, it asks for the include angle theta for giving equivalent acceleration to each sensitive axes 5a, 6a, and 7a of X-Y-Z.
[0018] Namely, what is necessary is just to ask for the include angle theta to which G-sintheta which is 45 degree of G-cos theta-cos which is the component of gravitational acceleration G which acts on direction sensitive-axis of X 5a and direction sensitive-axis of Y 6a, and the component of gravitational acceleration G which acts on Z direction sensitive-axis 7a becomes equal, as shown in drawing 3 . Therefore, it is [0019] from 45 degree =G-sin[of G-cos theta-cos] theta. It becomes theta=tan -1 (2-1/2), a next door, and about 35.26 degrees.
[0020] Moreover, it is [0021] when top-face 1a of a pedestal 1, clamp-face 2b of block 2, and the include angle to make are set to alpha (90 degree-theta). It becomes alpha=tan -1 (21/2), a next door, and about 54.74 degrees.
[0022] three shaft equipped with the block 2 which has the above include angles theta (about 35.26 degrees) and alpha (about 54.74 degrees) -- an accelerometer -- the sensitivity calibration of an accelerometer 4 is performed three shafts by using gravitational acceleration G using the fixture for proofreading. Then, the same acceleration component (about 57.7% of the gravitational acceleration G) by gravitational acceleration G acts on each axial acceleration sensors 5, 6, and 7 of X-Y-Z, respectively.
[0023] therefore, three shaft as shown in drawing 4 -- an accelerometer -- if a calibrating apparatus adjusts gain, such as amplifier 8 and a drop 9, etc. so that the output voltage of each axial acceleration sensors 5, 6, and 7 of X-Y-Z may display the same value (about 565 Gal), the sensitivity calibration of each axial acceleration sensors 5, 6, and 7 can carry out by attaching an accelerometer 4 in the fixture for proofreading only once three shafts.
[0024] three shaft concerning invention of claim 2 -- an accelerometer -- the fixture for proofreading consists of block 12 laid in top-face 11a of the metal pedestal 11 and a pedestal 11 as shown in drawing 5 , and the **** 14 for immobilization fixed to the shaking table 13 of excitation equipment is formed in the pedestal 11. In addition, A expresses the magnitude of acceleration while showing the direction of excitation by excitation equipment.
[0025] Block 12 is formed in the right-angle triangle pole with a metallic material (for example, aluminum), and the include angle of each vertical angle of the right triangle which are top-face 12a of the right-angle triangle pole and a base becomes about 54.74 degrees by 90 degrees and tan-1 (21/2), and has become about 35.26 degrees by tan-1 (2-1/2), respectively. In addition, about the reason for having set up the include angle of each vertical angle as mentioned above, it mentions later.
[0026] And top-face 11a of a pedestal 11 is touched in the side face of the right-angle triangle pole in which a 54.74-degree vertical angle counters, and the block 12 is laid in top-face 11a of a pedestal 11. Moreover, three pin 12c which carries out positioning immobilization of the accelerometer 14 three shafts protrudes on clamp-face 12b which is the side face of the right-angle triangle pole in which a 90-degree vertical angle counters perpendicularly. Therefore,

clamp-face 12b will form about 35.26-degree flat surface to top-face 11a of excitation of a pedestal 11, i.e., the direction.
[0027] the servo which has sensibility also in the gravitational acceleration (DC field) which is set as the object of a sensitivity calibration, and which shows an accelerometer 14 to drawing 2 three shaft -- the piezo-electric type which has neither an accelerometer nor the sensibility in gravitational acceleration (DC field) -- it is an accelerometer etc.
[0028] three shaft concerning invention of claim 2 constituted as mentioned above -- an accelerometer -- an operation of the fixture for proofreading is explained. As shown in drawing 5 R> 5, pin 12c is fitted into 18d of mounting holes, and an accelerometer 14 is fixed to block 12 three shaft. At this time, as shown in drawing 6 (a), acceleration A, clamp-face 12b of block 12, and the include angle to make are set to beta. Then, a component parallel to clamp-face 12b of the block 12 of acceleration A is set to A-cosbeta, and a perpendicular component is set to A-sinbeta.
[0029] And as shown in drawing 6 (b), an accelerometer 14 is fixed to clamp-face 12b of block 12 three shafts so that it may be in agreement with the shaft H with which the direction of A-cosbeta which is the component of acceleration A divides into two equally the angle (90 degrees) which direction sensitive-axis of X 5a of an accelerometer 14 and direction sensitive-axis of Y 6a make three shafts.
[0030] Therefore, A-sinbeta which is a component perpendicular to clamp-face 12b acts on Z direction sensitive-axis 7a, and 45 degree of A-cos beta-cos act on direction sensitive-axis of X 5a, and direction sensitive-axis of Y 6a. Here, it asks for the include angle beta for giving equivalent acceleration to each sensitive axes 5a, 6a, and 7a of X-Y-Z.
[0031] Namely, what is necessary is just to ask for the include angle beta to which A-sinbeta which is 45 degree of A-cos beta-cos which is the component of acceleration A which acts on direction sensitive-axis of X 5a and direction sensitive-axis of Y 6a, and the component of acceleration A which acts on Z direction sensitive-axis 7a becomes equal, as shown in drawing 6 . Therefore, it is [0032] from 45 degree =A-sin[of A-cos beta-cos] beta. It becomes beta=tan -1 (2-1/2), a next door, and about 35.26 degrees.
[0033] three shaft equipped with the block 12 which has the above include angles beta (about 35.26 degrees) -- an accelerometer -- the sensitivity calibration of an accelerometer 14 is performed three shaft by using excitation equipment using the fixture for proofreading. Then, the same acceleration component (about 57.7% of the acceleration A) by acceleration A acts on each axial acceleration sensors 5, 6, and 7 of X-Y-Z, respectively.
[0034] Therefore, if a calibrating apparatus as shown in drawing 4 adjusts gain, such as amplifier 8 and a drop 9, etc. so that the output voltage of each axial acceleration sensors 5, 6, and 7 of X-Y-Z may display the same value, the sensitivity calibration of each axial acceleration sensors 5, 6, and 7 can carry out by attaching an accelerometer 14 in the fixture for proofreading only once three shafts.
[0035] In addition, although excitation equipment horizontal to drawing 5 was shown, as long as it uses the fixture for proofreading which has the clamp face where an include angle becomes about 35.26 degrees to the acceleration direction, you may be vertical excitation equipment.
[0036] Moreover, if it is set up so that the gravitational acceleration direction and the direction A of excitation of the excitation equipment shown in drawing 5 may cross at right angles Namely, if clamp-face 12b forms the include angle of tan-1 (21/2) (about 54.74 degrees) to the flat surface which intersects perpendicularly with the excitation acceleration direction the servo which has sensibility also in DC field -- if the sensitivity calibration using the gravitational acceleration G of an accelerometer is performed, the component of the following gravitational acceleration G will act on each axial acceleration sensors 5, 6, and 7.
[0037] If gravitational acceleration G is set to 980Gal, the component of gravitational acceleration G which acts on the Z-axis acceleration sensor 7 will be set to 980xsin(54.74 degrees) =800, and the component of gravitational acceleration G which acts on the X-axis acceleration sensor 5 and the Y-axis acceleration sensor 6 will be set to 980xcos(54.74 degrees) xcos(45 degrees) =400. That is, the component of the good gravitational acceleration G of the end called 800Gal will act on 400Gal and the Z-axis acceleration sensor 7 at the X-axis

acceleration sensor 5 and the Y-axis acceleration sensor 6.
[0038] Therefore, the sensitivity calibration using gravitational acceleration G and the acceleration A of excitation equipment can carry out by performing attachment to the fixture for proofreading of an accelerometer 14 only once three shafts.
[0039] Even when performing the sensitivity calibration of an accelerometer 4 three shaft using gravitational acceleration G If accelerometers 4 and 14 are fixed to the clamp face where an include angle becomes tan-1 (2-1/2) (about 35.26 degrees) to the acceleration direction three shaft like the above even when performing the sensitivity calibration of an accelerometer 14 three shaft using excitation equipment The same acceleration component (gravitational acceleration G or about 57.7% of the acceleration A) acts on each axial acceleration sensors 5, 6, and 7 of X-Y-Z.
[0040] Moreover, when performing the sensitivity calibration of an accelerometer 4 three shaft using gravitational acceleration G, or when performing the sensitivity calibration of an accelerometer 14 three shaft using excitation equipment, since blocks 2 and 12 can be formed in the same configuration, they can be common-use-ized by the method of installation or immobilization in top-face 1a of a pedestal 1, or a shaking table 13.
[0041] that is, when touching top-face 1a of a pedestal 1 in the side face in which the 35.26-degree vertical angle of the top faces 2a and 12a of the blocks 2 and 12 which are right angled triangles counters and laying the block 2 in top-face 1a of a pedestal 1, gravitational acceleration G was used -- the sensitivity calibration of an accelerometer 4 can be performed three shaft. excitation equipment was used, when the shaking table 13 was touched in the side face in which a 54.74-degree vertical angle counters, on the other hand and the block 2 was fixed to the shaking table 13 -- the sensitivity calibration of an accelerometer 14 can be performed three shaft.
[0042] moreover, three shaft shown in drawing 1 -- an accelerometer -- if the fixture for proofreading is fixed to vertical excitation equipment and it excites in the gravitational acceleration direction when performing the sensitivity calibration of an accelerometer 4 three shaft using the fixture for proofreading, the sensitivity calibration using gravitational acceleration G and the acceleration of excitation equipment can be performed by performing attachment to the fixture for proofreading of an accelerometer 4 only once three shafts.
[0043] moreover, three shaft with which the sensitivity calibration of each axial acceleration sensors 5, 6, and 7 of X-Y-Z has already been performed by each axial independent one and which takes three shaft at this invention in the case of accelerometers 4 and 14 -- an accelerometer -- it becomes possible by performing a sensitivity calibration using the fixture for proofreading to get to know the precision with a group of each axial acceleration sensors 5, 6, and 7.
[0044] Moreover, if the acceleration sensor which has a polarity in each shaft of X and Y-Z is used, the attachment condition of an acceleration sensor can be checked from the phase relation of the output signal of each acceleration sensor.
[0045]
[Effect of the Invention] Since the sensitivity calibration of an accelerometer can be performed to 3 shaft coincidence three shafts according to this invention if an accelerometer is fixed to the clamp face of the fixture for proofreading three shafts as explained above, the attachment to the fixture for proofreading of an accelerometer can be managed at once three shafts, and speeding up of the sensitivity calibration of an accelerometer can be attained three shafts.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] three shaft concerning invention of claim 1 -- an accelerometer -- the perspective view of the fixture for proofreading
[Drawing 2] For the configuration explanatory view of an accelerometer, and (a), the plot plan of an acceleration sensor and (b) are the side elevation of an accelerometer three shaft three shaft.
[Drawing 3] three shaft concerning invention of claim 1 -- an accelerometer -- the operation explanatory view of the fixture for proofreading, drawing in which (a) shows a gravitational acceleration component perpendicular to the clamp face of an accelerometer, and parallel three shaft, and drawing in which (b) shows the decomposition condition to X and the Y-axis of a gravitational acceleration component parallel to the clamp face of an accelerometer three shaft
[Drawing 4] It is the outline block diagram of the calibrating apparatus of an accelerometer three shaft.
[Drawing 5] three shaft concerning invention of claim 2 -- an accelerometer -- the perspective view of the fixture for proofreading
[Drawing 6] three shaft concerning invention of claim 2 -- an accelerometer -- the operation explanatory view of the fixture for proofreading, drawing in which (a) shows an acceleration component perpendicular to the clamp face of an accelerometer, and parallel three shaft, and drawing in which (b) shows the decomposition condition to X and the Y-axis of an acceleration component parallel to the clamp face of an accelerometer three shaft
[Description of Notations]
1 11 [-- The top face of a block 2b, 12b / -- A clamp face, 3 / -- 4 Level, 14 / -- It is an accelerometer and 5 three shafts. / -- An X-axis acceleration sensor, the direction sensitive axis of 5 a--X 6 / -- A Y-axis acceleration sensor, the direction sensitive axis of 6 a--Y 7 / -- Z-axis acceleration sensor, 7a / -- A Z direction sensitive axis, 13 / -- A shaking table, 14 / -- **** for immobilization.] -- A pedestal, 1a, 11a -- 2 The top face of a pedestal, 12 -- A block, 2a, 12a

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[Translation done.]

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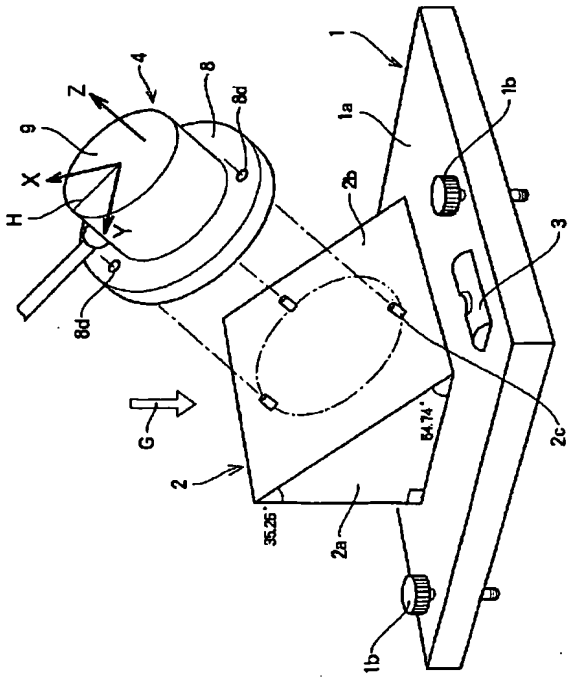
(54)【発明の名称】　３軸加速度計校正用治具

(57)【要約】
【課題】　各軸の感度調整を行う毎に、３軸加速度計を校正用治具に固定し直さなければならない。
【解決手段】　重力加速度Ｇを利用して３軸加速度計４の感度校正を行う場合に３軸加速度計４を固定する校正用治具であって、重力加速度方向と直交する平面１ａに対して、角度がｔａｎ$^{-1}$（$2^{1/2}$）（約５４．７４°）となる取付面２ｂを備え、この取付面２ｂに３軸加速度計４のＸ方向受感軸とＹ方向受感軸に等しい重力加速度が作用するように３軸加速度計４を取付ける。



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【特許請求の範囲】

【請求項１】　重力加速度を利用して３軸加速度計の感度校正を行う場合に前記３軸加速度計を固定する校正用治具であって、重力加速度方向と直交する平面に対して、角度が$\tan^{-1}(2^{1/2})$となる取付面を備え、この取付面に前記３軸加速度計のＸ方向受感軸とＹ方向受感軸に等しい重力加速度が作用するように前記３軸加速度計を取付けることを特徴とする３軸加速度計校正用治具。

【請求項２】　加振装置を利用して３軸加速度計の感度校正を行う場合に前記３軸加速度計を固定する校正用治具であって、加速度方向と直交する平面に対して、角度が$\tan^{-1}(2^{1/2})$となる取付面を備え、この取付面に前記３軸加速度計のＸ方向受感軸とＹ方向受感軸に等しい加速度が作用するように前記３軸加速度計を取付けることを特徴とする３軸加速度計校正用治具。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、互いに直交する受感軸を有する３軸加速度計の感度校正に際して用いる３軸加速度計校正用治具に関する。

【０００２】

【従来の技術】従来の３軸加速度計校正用治具としては、直交３軸（Ｘ、Ｙ、Ｚ）の加速度計、例えばサーボ加速度計の感度校正を重力加速度を利用して行う場合に、受感軸方向を重力加速度方向に一致させるため、各受感軸毎に加速度計を固定し直す校正用治具が知られている。また、圧電形加速度計の感度校正を加振装置を利用して行う場合にも、受感軸方向を加速度方向に一致させるため、各受感軸毎に加速度計を固定し直す校正用治具が知られている。

【０００３】即ち、３軸の感度校正を行うのに、先ずＺ軸加速度センサの受感軸に加速度方向が一致するように加速度計を校正用治具に固定させて所定の感度になるように感度調整を行い、次いでＸ軸加速度センサの受感軸に加速度方向が一致するように加速度計を校正用治具に固定させて所定の感度になるように感度調整を行い、更にＺ軸加速度センサの受感軸に加速度方向が一致するように加速度計を校正用治具に固定させて所定の感度になるように感度調整を行う。

【０００４】

【発明が解決しようとする課題】従来の３軸加速度計校正用治具においては、各軸の感度調整を行う毎に、加速度計を固定し直さなければならず、校正用治具への加速度の取付作業が煩雑であり、感度校正を迅速に行うのが困難であった。

【０００５】本発明は、従来の技術が有するこのような問題点に鑑みてなされたものであり、その目的とするところは、１回の校正用治具への取付作業で３軸加速度計の感度校正が行える３軸加速度計校正用治具を提供しようとするものである。

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【０００６】

【課題を解決するための手段】上記課題を解決すべく請求項１の発明は、重力加速度を利用して３軸加速度計の感度校正を行う場合に前記３軸加速度計を固定する校正用治具であって、重力加速度方向と直交する平面に対して、角度が$\tan^{-1}(2^{1/2})$となる取付面を備え、この取付面に前記３軸加速度計のＸ方向受感軸とＹ方向受感軸に等しい重力加速度が作用するように前記３軸加速度計を取付けるものである。

【０００７】請求項２の発明は、加振装置を利用して３軸加速度計の感度校正を行う場合に前記３軸加速度計を固定する校正用治具であって、加速度方向と直交する平面に対して、角度が$\tan^{-1}(2^{1/2})$となる取付面を備え、この取付面に前記３軸加速度計のＸ方向受感軸とＹ方向受感軸に等しい加速度が作用するように前記３軸加速度計を取付けるものである。

【０００８】

【発明の実施の形態】以下に本発明の実施の形態を添付図面に基づいて説明する。ここで、図１は請求項１の発明に係る３軸加速度計校正用治具の斜視図、図２は３軸加速度計の構成説明図、図３は請求項１の発明に係る３軸加速度計校正用治具の作用説明図、図４は３軸加速度計の校正装置の概要ブロック図、図５は請求項２の発明に係る３軸加速度計校正用治具の斜視図、図６は請求項２の発明に係る３軸加速度計校正用治具の作用説明図である。

【０００９】請求項１の発明に係る３軸加速度計校正用治具は、図１に示すように、金属製の基台１と、基台１の上面１ａに載置するブロック２からなり、基台１には上面１ａに重力加速度方向と直交する水平面を形成させるための調整ねじ１ｂが設けられている。なお、３は基台１の上面１ａが水平面になるのを確認する水準器である。

【００１０】ブロック２は、金属材料（例えば、アルミニウム）で直角三角柱に形成され、直角三角柱の上面２ａ及び底面である直角三角形の各頂角の角度は、夫々９０°、$\tan^{-1}(2^{-1/2})$で約３５．２６°、$\tan^{-1}(2^{1/2})$で約５４．７４°となっている。なお、各頂角の角度を上述のように設定した理由については後述する。

【００１１】そして、３５．２６°の頂角が対向する直角三角柱の側面を基台１の上面１ａに接して、ブロック２は基台１の上面１ａに載置されている。また、９０°の頂角が対向する直角三角柱の側面である取付面２ｂには、３軸加速度計４を位置決め固定する３本のピン２ｃが垂直に突設されている。従って、取付面２ｂは、重力加速度方向に対して約３５．２６°、基台１の上面１ａに対して約５４．７４°の平面を形成することになる。

【００１２】３軸加速度計４は、図２に示すように、受

感軸を互いに直交させてＸ軸加速度センサ５、Ｙ軸加速度センサ６、Ｚ軸加速度センサ７を円盤状のベース８の上面８ａに配設し、ベース８の上面８ａに円柱状のケース９を被せて構成され、重力加速度（ＤＣ領域）においても感度を有するサーボ加速度計である。なお、３軸加速度計４としては、ＤＣ領域の感度を有する、例えばストレインゲージ式加速度計でもよい。

【００１３】Ｘ軸加速度センサ５及びＹ軸加速度センサ６は、それらの受感軸がベース８の上面８ａと平行に配設され、Ｚ軸加速度センサ７は、その受感軸がベース８の上面８ａと垂直に配設されている。また、ベース８のフランジ部８ｂには、ピン２ｃを嵌合してベース８の底面８ｃをブロック２の取付面２ｂに密着させてブロック２に固定する取付孔８ｄが形成されている。

【００１４】３軸加速度計４をブロック２の取付面２ｂに固定すると、Ｘ軸加速度センサ５及びＹ軸加速度センサ６は、それらの受感軸が取付面２ｂに対して平行になり、Ｚ軸加速度センサ７は、その受感軸が取付面２ｂに対して垂直になる。

【００１５】以上のように構成した請求項１の発明に係る３軸加速度計校正用治具の作用について説明する。図１に示すように、ピン２ｃを取付孔８ｄに嵌合して３軸加速度計４をブロック２に固定する。この時、図３（ａ）に示すように、重力加速度Ｇとブロック２の取付面２ｂとなす角度をθとする。すると、重力加速度Ｇのブロック２の取付面２ｂに平行な成分はＧ・ｃｏｓθ、垂直な成分はＧ・ｓｉｎθとなる。

【００１６】そして、図３（ｂ）に示すように、重力加速度Ｇの成分であるＧ・ｃｏｓθの方向が、３軸加速度計４のＸ方向受感軸５ａとＹ方向受感軸６ａのなす角（９０°）を２等分する軸Ｈに一致するように、３軸加速度計４がブロック２の取付面２ｂに固定される。

【００１７】従って、Ｚ方向受感軸７ａには、取付面２ｂに垂直な成分であるＧ・ｓｉｎθが作用し、Ｘ方向受感軸５ａ及びＹ方向受感軸６ａには、Ｇ・ｃｏｓθ・ｃｏｓ４５°が作用する。ここで、Ｘ・Ｙ・Ｚの各受感軸５ａ，６ａ，７ａに同等な加速度を与えるための角度θを求める。

【００１８】即ち、図３に示すように、Ｘ方向受感軸５ａ及びＹ方向受感軸６ａに作用する重力加速度Ｇの成分であるＧ・ｃｏｓθ・ｃｏｓ４５°と、Ｚ方向受感軸７ａに作用する重力加速度Ｇの成分であるＧ・ｓｉｎθが等しくなる角度θを求めればよい。従って、Ｇ・ｃｏｓθ・ｃｏｓ４５°＝Ｇ・ｓｉｎθより、

【００１９】$\theta = \tan^{-1}(2^{-1/2})$、となり、約３５．２６°となる。

【００２０】また、基台１の上面１ａとブロック２の取付面２ｂとなす角度をα（９０°－θ）とすると、

【００２１】$\alpha = \tan^{-1}(2^{1/2})$、となり、約５４．７４°となる。

【００２２】以上のような角度θ（約３５．２６°），α（約５４．７４°）を有するブロック２を備えた３軸加速度計校正用治具を用いて重力加速度Ｇを利用することにより、３軸加速度計４の感度校正を行う。すると、Ｘ・Ｙ・Ｚの各軸加速度センサ５，６，７には、夫々重力加速度Ｇによる同一の加速度成分（重力加速度Ｇの約５７．７％）が作用する。

【００２３】従って、図４に示すような３軸加速度計校正装置で、Ｘ・Ｙ・Ｚの各軸加速度センサ５，６，７の出力電圧が同一の値（約５６５Ｇａｌ）を表示するように増幅器８や表示器９などのゲイン等を調整すれば、各軸加速度センサ５，６，７の感度校正が、３軸加速度計４を校正用治具に１回だけ取付けることにより実施できる。

【００２４】請求項２の発明に係る３軸加速度計校正用治具は、図５に示すように、金属製の基台１１と、基台１１の上面１１ａに載置するブロック１２からなり、基台１１には加振装置の加振台１３に固定する固定用ねじ１４が設けられている。なお、Ａは加振装置による加振方向を示すと共に、加速度の大きさを表す。

【００２５】ブロック１２は、金属材料（例えば、アルミニウム）で直角三角柱に形成され、直角三角柱の上面１２ａ及び底面である直角三角形の各頂角の角度は、夫々９０°、$\tan^{-1}(2^{1/2})$で約５４．７４°、$\tan^{-1}(2^{-1/2})$で約３５．２６°となっている。なお、各頂角の角度を上述のように設定した理由については後述する。

【００２６】そして、５４．７４°の頂角が対向する直角三角柱の側面を基台１１の上面１１ａに接して、ブロック１２は基台１１の上面１１ａに載置されている。また、９０°の頂角が対向する直角三角柱の側面である取付面１２ｂには、３軸加速度計１４を位置決め固定する３本のピン１２ｃが垂直に突設されている。従って、取付面１２ｂは、基台１１の上面１１ａ、即ち加振方向に対して約３５．２６°の平面を形成することになる。

【００２７】感度校正の対象となる３軸加速度計１４は、図２に示す重力加速度（ＤＣ領域）においても感度を有するサーボ加速度計や、重力加速度（ＤＣ領域）における感度を有さない圧電式加速度計などである。

【００２８】以上のように構成した請求項２の発明に係る３軸加速度計校正用治具の作用について説明する。図５に示すように、ピン１２ｃを取付孔１８ｄに嵌合して３軸加速度計１４をブロック１２に固定する。この時、図６（ａ）に示すように、加速度Ａとブロック１２の取付面１２ｂとなす角度をβとする。すると、加速度Ａのブロック１２の取付面１２ｂに平行な成分はＡ・ｃｏｓβ、垂直な成分はＡ・ｓｉｎβとなる。

【００２９】そして、図６（ｂ）に示すように、加速度Ａの成分であるＡ・ｃｏｓβの方向が、３軸加速度計１４のＸ方向受感軸５ａとＹ方向受感軸６ａのなす角（９

０°）を２等分する軸Ｈに一致するように、３軸加速度計１４がブロック１２の取付面１２ｂに固定される。

【００３０】従って、Ｚ方向受感軸７ａには、取付面１２ｂに垂直な成分であるＡ・ｓｉｎβが作用し、Ｘ方向受感軸５ａ及びＹ方向受感軸６ａには、Ａ・ｃｏｓβ・ｃｏｓ４５°が作用する。ここで、Ｘ・Ｙ・Ｚの各受感軸５ａ，６ａ，７ａに同等な加速度を与えるための角度βを求める。

【００３１】即ち、図６に示すように、Ｘ方向受感軸５ａ及びＹ方向受感軸６ａに作用する加速度Ａの成分であるＡ・ｃｏｓβ・ｃｏｓ４５°と、Ｚ方向受感軸７ａに作用する加速度Ａの成分であるＡ・ｓｉｎβが等しくなる角度βを求めればよい。従って、Ａ・ｃｏｓβ・ｃｏｓ４５°＝Ａ・ｓｉｎβより、

【００３２】$\beta = \tan^{-1}(2^{-1/2})$、となり、約３５．２６°となる。

【００３３】以上のような角度β（約３５．２６°）を有するブロック１２を備えた３軸加速度計校正用治具を用いて加振装置を利用することにより３軸加速度計１４の感度校正を行う。すると、Ｘ・Ｙ・Ｚの各軸加速度センサ５，６，７には、夫々加速度Ａによる同一の加速度成分（加速度Ａの約５７．７％）が作用する。

【００３４】従って、図４に示すような校正装置で、Ｘ・Ｙ・Ｚの各軸加速度センサ５，６，７の出力電圧が同一の値を表示するように増幅器８や表示器９などのゲイン等を調整すれば、各軸加速度センサ５，６，７の感度校正が、３軸加速度計１４を校正用治具に１回だけ取付けることにより実施できる。

【００３５】なお、図５には水平方向の加振装置を示したが、加速度方向に対して角度が、約３５．２６°となる取付面を有する校正用治具を用いれば、垂直方向の加振装置であってもよい。

【００３６】また、図５に示す加振装置の加振方向Ａが重力加速度方向と直交するように設定されていれば、即ち取付面１２ｂが加振加速度方向と直交する平面に対して、$\tan^{-1}(2^{1/2})$（約５４．７４°）の角度を形成していれば、ＤＣ領域においても感度を有するサーボ加速度計の重力加速度Ｇを利用した感度校正を行うと、次のような重力加速度Ｇの成分が各軸加速度センサ５，６，７に作用する。

【００３７】重力加速度Ｇを９８０Ｇａｌとすると、Ｚ軸加速度センサ７に作用する重力加速度Ｇの成分は、９８０×ｓｉｎ（５４．７４°）＝８００となり、Ｘ軸加速度センサ５とＹ軸加速度センサ６に作用する重力加速度Ｇの成分は、９８０×ｃｏｓ（５４．７４°）×ｃｏｓ（４５°）＝４００となる。即ち、Ｘ軸加速度センサ５とＹ軸加速度センサ６には、４００Ｇａｌ、Ｚ軸加速度センサ７には、８００Ｇａｌという切りのよい重力加速度Ｇの成分が作用することになる。

【００３８】従って、重力加速度Ｇ及び加振装置の加速度Ａを利用した感度校正が、３軸加速度計１４の校正用治具への取付作業を１回だけ行うことにより実施することができる。

【００３９】重力加速度Ｇを利用して３軸加速度計４の感度校正を行う場合でも、加振装置を利用して３軸加速度計１４の感度校正を行う場合でも、加速度方向に対して角度が、$\tan^{-1}(2^{-1/2})$（約３５．２６°）となる取付面に、前記の如く３軸加速度計４，１４を固定すれば、Ｘ・Ｙ・Ｚの各軸加速度センサ５，６，７に同一の加速度成分（重力加速度Ｇ又は加速度Ａの約５７．７％）が作用する。

【００４０】また、重力加速度Ｇを利用して３軸加速度計４の感度校正を行う場合でも、加振装置を利用して３軸加速度計１４の感度校正を行う場合でも、ブロック２，１２は、同一の形状に形成することができるので、基台１の上面１ａ又は加振台１３への載置又は固定の仕方により共用化することができる。

【００４１】即ち、直角三角形であるブロック２，１２の上面２ａ，１２ａの３５．２６°の頂角が対向する側面を基台１の上面１ａに接して、ブロック２を基台１の上面１ａに載置すれば、重力加速度Ｇを利用した３軸加速度計４の感度校正が行える。一方、５４．７４°の頂角が対向する側面を加振台１３に接して、ブロック２を加振台１３に固定すれば、加振装置を利用した３軸加速度計１４の感度校正が行える。

【００４２】また、図１に示す３軸加速度計校正用治具を用いて３軸加速度計４の感度校正を行う場合に、垂直方向の加振装置に校正用治具を固定して重力加速度方向に加振すれば、３軸加速度計４の校正用治具への取付作業を１回だけ行うことにより、重力加速度Ｇ及び加振装置の加速度を利用した感度校正を行うことができる。

【００４３】また、Ｘ・Ｙ・Ｚの各軸加速度センサ５，６，７の感度校正が、既に各軸単独で行われている３軸加速度計４，１４の場合には、本発明に係る３軸加速度計校正用治具を用いて感度校正を行うことにより、各軸加速度センサ５，６，７の組付精度を知ることが可能になる。

【００４４】また、Ｘ・Ｙ・Ｚの各軸に極性のある加速度センサを使用すれば、各加速度センサの出力信号の位相関係から加速度センサの取付状態のチェックを行える。

【００４５】

【発明の効果】以上説明したように本発明によれば、３軸加速度計を校正用治具の取付面に固定すれば、３軸加速度計の感度校正を３軸同時に行うことができるので、３軸加速度計の校正用治具への取付作業が１回で済み、３軸加速度計の感度校正の迅速化が図れる。

【図面の簡単な説明】

【図１】請求項１の発明に係る３軸加速度計校正用治具の斜視図

【図２】３軸加速度計の構成説明図、（ａ）は加速度センサの配置図、（ｂ）は３軸加速度計の側面図

【図３】請求項１の発明に係る３軸加速度計校正用治具の作用説明図、（ａ）は３軸加速度計の取付面に垂直及び平行な重力加速度成分を示す図、（ｂ）は３軸加速度計の取付面に平行な重力加速度成分のＸ・Ｙ軸への分解状態を示す図

【図４】３軸加速度計の校正装置の概要ブロック図

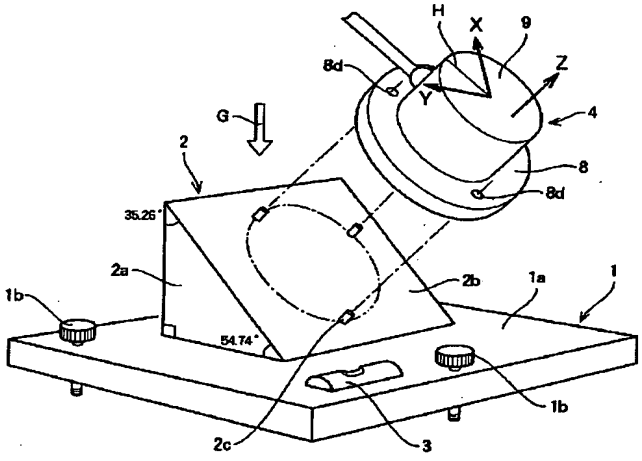
【図５】請求項２の発明に係る３軸加速度計校正用治具の斜視図

【図６】請求項２の発明に係る３軸加速度計校正用治具の作用説明図、（ａ）は３軸加速度計の取付面に垂直及＊び平行な加速度成分を示す図、（ｂ）は３軸加速度計の取付面に平行な加速度成分のＸ・Ｙ軸への分解状態を示す図

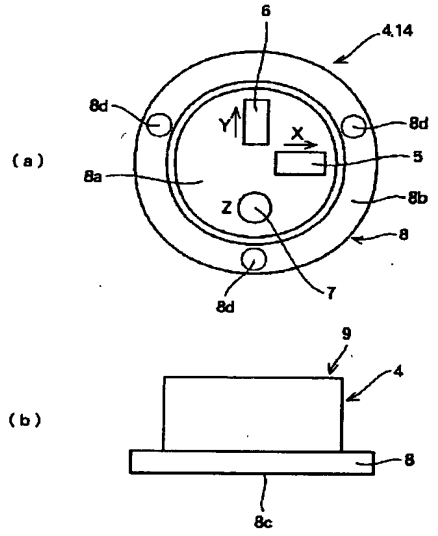
【符号の説明】

１，１１…基台、１ａ，１１ａ…基台の上面、２，１２…ブロック、２ａ，１２ａ…ブロックの上面、２ｂ，１２ｂ…取付面、３…水準器、４，１４…３軸加速度計、５…Ｘ軸加速度センサ、５ａ…Ｘ方向受感軸、６…Ｙ軸加速度センサ、６ａ…Ｙ方向受感軸、７…Ｚ軸加速度センサ、７ａ…Ｚ方向受感軸、１３…加振台、１４…固定用ねじ。

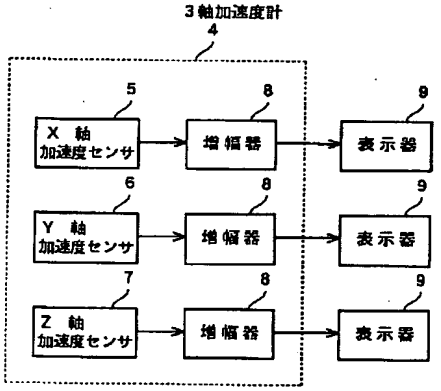
【図１】



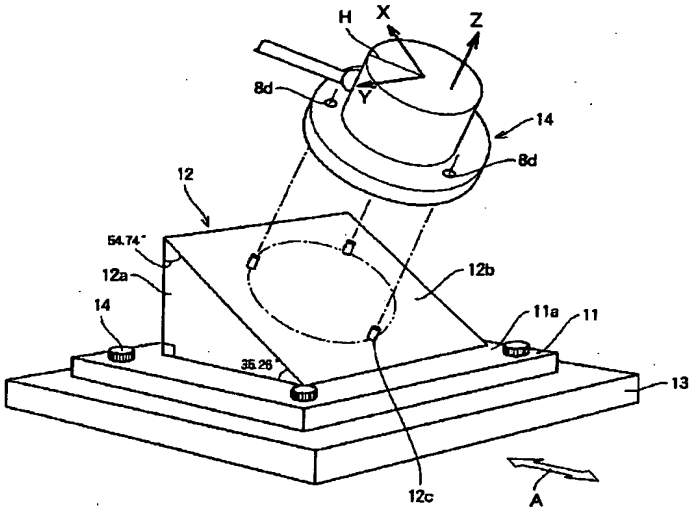
【図２】



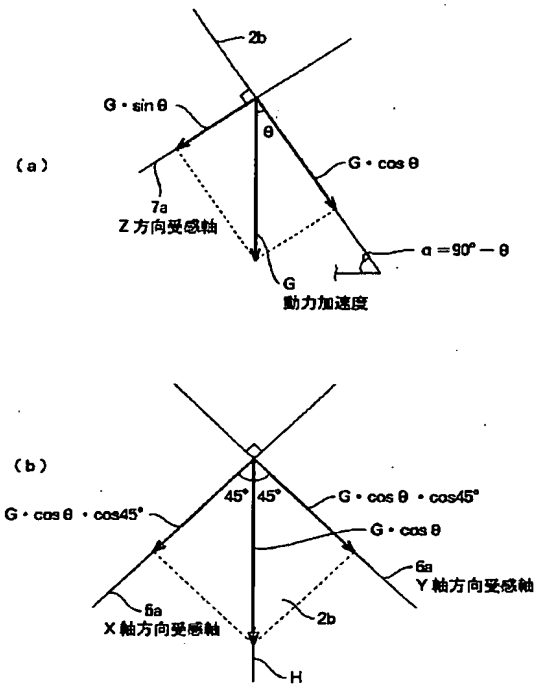
【図４】



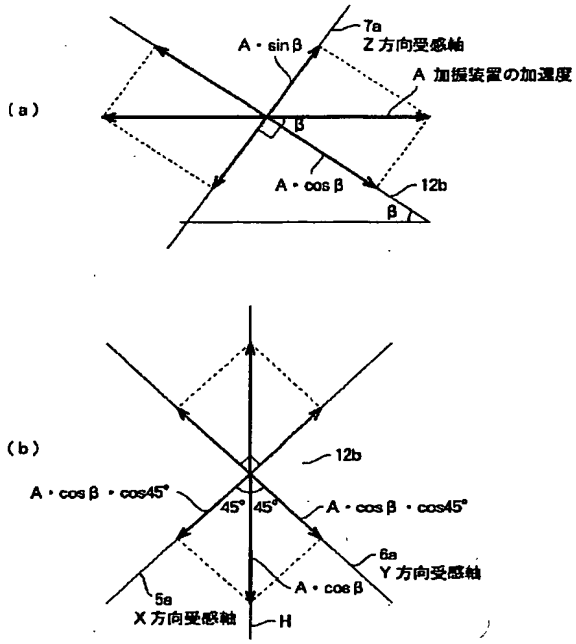
【図５】



【図３】


(a)
2b
G・sinθ
θ
G・cosθ
7a
Z方向受感軸
α＝90°－θ
G
動力加速度
(b)
G・cosθ・cos45°
45°
45°
G・cosθ・cos45°
G・cosθ
6a
Y軸方向受感軸
5a
X軸方向受感軸
2b
H

【図６】


(a)
A・sinβ
7a
Z方向受感軸
A 加振装置の加速度
β
A・cosβ
12b
β
(b)
12b
A・cosβ・cos45°
45°
45°
A・cosβ・cos45°
6a
Y方向受感軸
A・cosβ
5a
X方向受感軸
H